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ABSTRACT

Over the past decade, momentum has been gathering for the development and application of a variety of approaches to the instructional process that emphasize mastery and self-pacing by the student. Included are approaches such as programmed instruction, computer-aided instruction, and individually prescribed instruction. This review considers one such approach that is being used more and more widely in higher education, the Personalized System of Instruction (PSI). This paper describes the brief history of PSI and its basic conceptual ingredients and provides an indepth look at a typical PSI classroom. It also reviews research that compares PSI to more traditional forms of instruction, identifies information programs and knowledgeable individuals, and speculates on the future of PSI. (MJM)

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The Personalized System of Instruction: An Educational Alternative

Robert S. Ruskin

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Robert S. Ruskin

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Foreword

Over the past decade, momentum has been gathering for the development and application of a variety of approaches to the instructional process that emphasize mastery and self-pacing by the student. Included are approaches such as programmed instruction, computer-aided instruction, and individually prescribed instruction. This review considers one such approach that is being used more and more widely in higher education, the Personalized System of Instruction (PSI). This paper describes the brief history of PSI and its basic conceptual ingredients and provides an in-depth look at a typical PSI classroom. It also reviews research that compares PSI to more traditional forms of instruction, identifies informational programs and knowledgeable individuals, and speculates on the future of PSI. The author, Robert S. Ruskin, is the Associate Director of the Center for Personalized Instruction and on the faculty of the Department of Psychology at Georgetown University, Washington, D. C.

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The Fifth Revolution

Sir Eric Ashby (1967) has discussed four important revolutions relating to the education of man:

(1) The shifting of the task of educating the young in a society from the parents to a select group of adults. This new group developed specialized skills in the communication of knowledge and became known as "teachers," and the places in which the knowledge was communicated became known as "schools".

(2) Ashby feels that the second revolution came when teachers began using the written word instead of oral communication as the vehicle for instruction.

(3) The third revolution logically follows the second: the introduction and subsequent wide usage of printed material for education.

(4) The fourth major change in education came when significant technological advances ushered in widespread use of electromechanical devices. This revolution, Ashby feels, is characterized by the use of electronic equipment such as television, tape recorders, and computers to aid in information transfer.

These four developments in the educational process are indeed important. One can hardly imagine education advancing to its present level of sophistication without the first three revolutions.

The fourth revolution is extremely interesting and unique in its own right. For the first time the results of research and observations of instructional processes have been directly employed to make subsequent education a more enjoyable and effective process. This change in the state of education could be appropriately labeled the "hardware" revolution. As a result, education has new and varied vehicles to aid in the transfer of knowledge, and the traditional scholarly textbook can be supplemented effectively with other highly sophisticated modes of information transfer. The text may be enhanced or eliminated completely with the use of video-tape lectures or demonstrations, computer-generated educational material, and so on. This picture of education seems a rosy one at first glance, but there is a problem. The "hardware" revolution needs a framework within which to operate. The best machine will make little impact in the existing educational system if it functions in an environment that is not conducive to efficient information transfer from teacher to student.

If the advent of hardware on the educational scene denotes the fourth revolution, then a *fifth* revolution seems to have been spawned. This revolution could be deemed the "software revolution". For the first time the specific variables involved in the instructional process are being systematically viewed, quantified, and altered to produce significant and beneficial changes in education. The variables affecting the instructional process are many, and will be developed at some length in later sections, but it is important at this juncture to take note of some of the major ones. A few of the variables that affect any learning situation are: (1) the proper division and sequencing of information to be learned in order to promote the occurrence of more efficient learning; (2) the use of supplementary study guides or aids to insure that the learner has complete knowledge of the material to be learned; (3) the proper use of temporal contingencies to increase efficiency in learning; and (4) the proper coordination of written materials with personnel and hardware to insure effective instruction.

We should note at this point the different meanings given to "education" and "instruction". Instruction refers to the specific techniques or processes employed by the teacher to promote more efficient and effective learning; education refers to a much broader concept, encompassing the software instructional processes as well as the technological hardware necessary for implementation of many educational techniques.

Outline and Goals

The fifth revolution is an extremely recent phenomenon. Some of the instructional techniques that fall into this category include: the Personalized System of Instruction, Computer Assisted Instruction, the Audio Tutorial System, Individually Prescribed Instruction, and Programmed Instruction. Most of these techniques have originated within the past two decades, with a lion's share of their development taking place in the last 5 to 10 years. As happens with all newly developed ideas and techniques, the fifth revolution has its share of problems that will be explored in later sections.

Numerous references will be made in this paper to various aspects of the Personalized System of Instruction and its relationship to other forms of individualized instruction, as if each form of instruction were in some absolute and final form. It is essential that the reader realize that the logistical nuances described in the Personalized System of Instruction, research discussed, and various projects mentioned are in a constant and healthy state of change. With this in mind, what

follows is a summary of what the following sections will provide.

First, there will be a brief examination of the development of PSI from its beginnings in Brazil 10 years ago to the present. Particular attention will be given to the people and events instrumental in this system's extensive proliferation in the last decade.

Second, the basic conceptual ingredients that make the Personalized System of Instruction work will be surveyed. For this view, we will concentrate almost exclusively on the writings of the system's originators: Fred S. Keller and J. Gilmore Sherman.

Third, we will take an in-depth look at an "average" PSI classroom. Logistical considerations of many varieties will be discussed with the hope that the reader, upon completion of this section, will have a grasp of the major "do's" and "don'ts" of successful PSI classroom management.

Fourth, we will look at some of the research data comparing PSI to both more traditional forms of classroom teaching and to data that depicts various features of the instructional system. Following this research review, the probable future directions of research in this area will be briefly explored.

Fifth, we will discuss the current state of the art of PSI nationally. In this section, particular attention will be paid to the appropriate informational programs and individuals that educators may wish to contact to implement a PSI system at their institution.

Sixth, we will take a cautious look at where PSI and the "fifth revolution" may be headed in higher education over the next generation.

History of the Personalized System of Instruction

The beginnings of PSI can be traced to Fred S. Keller who was a graduate student at Harvard in the 1920's. Keller talked to a fellow student, B. F. Skinner, about his own views on various facets of the educational process. Both men continued their interest in the educational process after graduation. Keller (1968) notes that during World War II he tried to use the learning principle of immediate reinforcement while teaching Morse Code for the Signal Corps. He realized that the teaching environment in this type of Morse Code center was highly individualized; all goals of learning were specified and the material to be learned was divided into carefully graded steps. The demand for perfection was also present and was coupled with a unique division of course duties. The course instructors were responsible for the development and evaluation of course materials, the careful management of course procedures, and the selection of noncommissioned personnel who had recently finished the training program with distinction to serve as teacher's guides and test graders. This program contained all of the essentials for a successful personalized system of instruction.

In the early 1950's Keller, who was teaching at Columbia University, gained a reputation for innovation in instruction. Sherman (1971a), who was a graduate student at the time, noted that at Columbia "innovation was in the air." He suggests that the advent of programmed instruction, as well as the publication of Skinner's paper, "The Science of Learning and the Art of Teaching" (1954), made educators aware that, to teach most effectively, the following important elements of learning theory must be applied: (1) one must always present material to be learned by the student in small, sequential amounts with all terminal behavioral objectives well defined; (2) the learning situation must be structured so that every learner may receive immediate feedback on what he has learned through carefully constructed performance checks; and (3) punishment must be kept minimal. It seems that the stage was set at Columbia for a new type of instruction to develop.

Keller left Columbia in 1962 and was joined shortly by J. G. Sherman in Brazil. There, with two Brazilian colleagues, Rodolfo Azzi and Carolina Martuscelli Bori, a new Department of Psychology was

established at the developing University of Brazilia. The University was just being built, the curriculum was being developed, and the time semed ripe for a new approach to the application of reinforcement theory in a classroom setting. The course developed at the University of Brazilia was considered quite successful, but changes in the government produced disruptions in the universities for a time. Keller and Sherman returned to the United States after only one semester of operation.

Both men accepted positions at Arizona State University and began teaching courses modeled along the same lines as the Brazilian experiment. It should be emphasized that at that point (in early 1965) the technique as yet had no formal name, but its basic characteristics were described by Sherman (1971a): "We kept the essential characteristics of Skinner's programming, brought in the Brazilian influences of personal individual interaction and hired proctors to serve in the system."

The system of instruction began to blossom and by 1967 several papers had been delivered by both Keller and Sherman, as well as by one of the original Brazilian team, Azzi, to several professional conferences. Keller published his now well known article, "Goodbye Teacher," in 1968, and professionals in other disciplines began to take notice. Two disciplines in particular began large scale implementation of the new freshly labelled "Keller Plan". These disciplines, engineering and physics, appeared to be particularly well suited for such a system of instruction.

Courses were being developed concurrently by individuals in several disciplines during the period between 1968-1971. These courses were, on the whole, quite successful, but still confined largely to psychology and the so-called hard or physical sciences.

Ben A. Green, a physicist at the Massachusetts Institute of Technology, led a 2-week workshop largely for professors of physics in the New England region during the summer of 1971. This workshop was supported by the National Science Foundation. In the fall of 1971 a conference on the Keller Plan held at M.I.T. was attended by over 300 college and university professors. The conference again was attended primarily by those teaching in the behavioral or physical sciences, but the number of disciplines represented was growing. For the first time, research papers were presented by teachers from a variety of disciplines and institutions on the effects of various aspects of the Personalized System of Instruction.

June of 1971 saw the first issue of the *Personalized System of Instruction Newsletter*. This newsletter was started on a modest scale

by Sherman, at this time a member of the Psychology Department at Georgetown University. The first issue reached an initial readership of 400 interested college and university teachers and administrators. The readership began to increase dramatically as PSI was tried by new faculties across the country. R. S. Ruskin joined Sherman at Georgetown University and assumed duties as associate editor of the newsletter in 1972. The newsletter mailing list has now swelled to over 3,000, with 27 disciplines represented.

Two other major conferences on PSI were held in 1972, the first at Rice University in the spring and the second at Long Beach University in the fall. Enthusiasm for this new method of instruction continued to grow and it was becoming evident that psychology and the physical sciences no longer constituted the great majority of interested PSI users.

During the period between 1971-1973, a number of PSI workshops were given in several institutions across the U. S. and in several foreign nations, among them Venezuela, Brazil, and Mexico. Several hundred interested faculty members attended workshops held by Sherman and Ruskin at Georgetown, Green at M.I.T., and Stice and Koen at the University of Texas. These 2-week workshops proved highly successful in giving the new PSI user the skills necessary for implementation of a successful course.

This brief history brings us to the present, which sees the beginning of large-scale projects to study and disseminate information on PSI. In 10 short years, from its beginnings in Brazil, the Personalized System of Instruction has grown into one of the major innovations in higher education today.

Basic Principles of the Personalized System of Instruction

Use of the Personalized System of Instruction (PSI) has grown almost ten-fold in the last 5 years. Primarily, this growth has occurred in higher education, although recent trends seem to be carrying it even more rapidly into the areas of secondary and adult education.

Why did the Personalized System of Instruction originate in higher education, usually the last line of resistance to innovation? One reason seems to be the basic theoretical framework underlying the system. PSI was developed by two psychologists, F. S. Keller and J. G. Sherman, who were both firmly grounded in learning-reinforcement theory. Their knowledge of the many ingredients necessary for effective learning allowed them to develop a system of instruction that was both firmly established in existing learning theory and much different from programmed instruction. The difference between the two forms lies primarily in the fact that in Personalized Instruction the principle steps of advance are not "frames" in a "set," but are more like the conventional homework assignment or laboratory exercise (Keller 1968).

The PSI system differs from its predecessor in another basic dimension—"The response is not simply the completion of a prepared statement through the insertion of a word or phase. Rather it may be thought of as the result of many such responses, better described as the understanding of a principle, a formula, or a concept, or the ability to use an experimental technique" (Keller 1968, p. 24).

The preceding excerpts from one of Keller's initial articles on PSI, "Good[illegible] Teacher," discuss an instructional system that is theoretically very similar to programmed instruction but when put into practice at the level of a college classroom is quite different.

There are five fundamental characteristics of the Personalized System of Instruction:

The Stress Upon the Written Word

PSI places important emphasis on the written word for effective communication between the teacher and the learner. The standard textbook in many courses is often used as the basic source for whatever content the instructor wishes the students to learn. Using traditional texts has several obvious advantages in a personalized course,

the primary one being that material to be learned is presented in an organized and easily obtainable package. However, the average text usually has severe limitations with regard to effective teaching. The text, in most cases, is written by someone other than the teacher of the course. For this reason, the content presented as important in the text and the content considered important by the teacher do not always correspond. Even if the text does present content considered important by the teacher, texts are often written in such a way that important points of information are either not made clear to the student or are left out completely. As a by-product of an effort to keep a text reading well and flowing smoothly, listing of important points or in-depth discussion of these points is often compromised.

There is a way to use a traditional text and also gain the important benefits of presenting to the students the important aspects of content to be learned. This is done in PSI through the use of detailed study guides that are usually keyed to a specific text but written by the teacher himself. Students are presented with detailed study materials that vary according to stylistic differences among teachers, but are similar across PSI courses.

Study materials must present to the student all of the important learning goals for a given reading assignment. These goals are often presented as "behavioral objectives" and take the form of specific tests of terminal behaviors upon the completion of learning a specified amount of content.

Example: Upon completion of this Unit on "Learning Theory" you should be able to:

1. Define the term "reinforcement."
2. List the four major components of successful learning mentioned in the text.
3. State specifically the advantages of repeated trials in the learning process.

Notice that the behavioral objectives presented in the example include only material that can be readily demonstrated to the teacher by the student. Many PSI study guides do not list specific behavioral objectives in each unit of content to be learned but include the important behavioral objectives of learning in the form of study questions. While the exact form of presentation of goals in acquiring specific content is a function of the particular course and instructor, the necessity for such presentation is firmly established in learning theory. In other words, if the student doesn't know what is important for him to learn in a given area of content, and the instructor can't clarify

what is important, then the learning process will be inefficient and ineffective to say the least!

The usual PSI study materials have an "introduction" section that explains to the student why the material he is about to learn is important in relation to the other material he has previously learned. The introduction also discusses what strategies the student might follow when reading certain material. In the usual introduction, specific paragraphs, columns and pages of relevant text material are mentioned. This helps the student develop a useful strategy for accomplishing the defined behavioral objectives in each unit.

The Unit-Perfection Requirement

Long before any PSI course is undertaken, many decisions are made by the instructor. First, the instructor must decide what content is important for the course. He must then decide whether or not this amount of material to be learned is in fact reasonable for a course of that particular length. Once these decisions are made, still other decisions are necessary concerning the division of content into equivalent subdivisions. These subdivisions are termed "units" by Keller (1968). The number and size of units may vary from discipline to discipline or from instructor to instructor. The standing rule of thumb, however, is that there should be approximately one unit for each week of the course. (This means that for an average semester, a reasonable number of units for an average course would be 15.) There are good logistical reasons for this rule of thumb, most of which will be taken up at some length in the "Course Management" section of this monograph. Suffice it to say that the number of units should not become so large that student performance decreases as a result.

The previously mentioned procedures relating to complete unitization are important in setting the stage for the second basic defining characteristic of PSI, the unit-perfection requirement. This requirement states that to advance, a student may "go ahead to new materials only after demonstrating mastery of that which preceded" (Keller 1968, pg. 23).

This "mastery" concept requires a major change in traditional testing and grading procedures by most teachers. Tests are taken by students as many times as necessary on a given unit until a threshold level of mastery is reached. Sherman makes an impressive case for mastery in a paper presented before the West Coast PSI Conference in 1972:

> The tests are not exams in the normal sense. Students are not penalized by a lower grade because of errors. The tests are not graded at all, but rather are a device and an opportunity for the student to demonstrate mastery, or detect confusions, the latter to be corrected before they lead to serious trouble.
>
> Roughly, rather than starting with 100, counting errors and subtracting points that are forever lost, the procedure is to count successes and add. The difference is not trivial; for it leaves the student free to try; free to fail; and therefore eventually more likely to succeed. It is the amount he masters that determines his grade. We judge our art masterpieces not by the number of preliminary sketches discarded along the way, but the final product produced (Sherman 1972b).

The last sentence quoted is particularly compelling and deserves an additional comment. If one is interested in undergoing successful surgery or getting his automobile repaired, then the important consideration in viewing the surgeon or automobile mechanic is whether they have "mastered" the skills involved and not how long it took to gain the medical degree or the mechanics certification.

Questions have been raised about evaluation by some faculty members and administrators who feel that a "mastery" philosophy of education eliminates the discriminations one can make among students when a "normal curve" is employed. Bloom (1968) makes an important distinction between what he calls the teaching-learning process and the evaluation process and feels that "at some point in time the results of teaching and learning can be reflected in the evaluation of the students. But, these are *separate* processes." With regard to the "normal curve" in the grade distributions of many traditional courses in higher education, Bloom (1968) makes another important point:

> There is nothing sacred about the normal curve. It is the distribution most appropriate to chance and random activity. Education is a purposeful activity and we seek to have the students learn what we have to teach. If we are effective in our instruction, the distribution of achievement should be very different from the normal curve. In fact, we may even insist that our educational efforts have been unsuccessful to the extent to which our distribution approximates the normal distribution (pg. 2).

The fact that there are individual differences among students in terms of learning ability, and that these differences are reflected in the learning process, is not questioned by most who adhere to a "mastery" philosophy of learning. These differences among students might be reflected more adequately in differences in rate of learning of materials and not in the final level of learning achieved. As Sherman (1972b) puts it, mastery is synonymous with unit-perfection. Perfection cannot be controlled by the calendar and the clock—it demands

a self-paced system. It appears to be a law of education that *we cannot hold both time and quality constant.*

This, then, brings up the next of the five basic features of the Personalized System of Instruction, the "go-at-your-own-pace" feature.

Student Self-Pacing

The instructional system in higher education has been rigidly locked into an existing time sequence for quite a while. It comes as no surprise that the existing educational framework allows little temporal flexibility to the teacher. Semesters are neatly divided into 12- to 15-week packages and courses usually fit nicely into 50-minute hours three times a week. The surprise comes when one begins to realize how truly remarkable it is that all disciplines are so similar.

The "lock-step" or "instructor-paced" presentation of content produces a variety of problems well known to most teachers. In the instructor-paced system, the teacher decides what should be taught and when. This pace will either produce students who are "left-behind" in the course or students who are intensely bored by the slowness of content delivery. We all are familiar with the teacher who goes through the course too rapidly and leaves most of his students behind. We are also familiar with those teachers who are viewed as too easy or boring because of their slow delivery of content.

Self-pacing by the student allows him to proceed through units in the PSI course as rapidly as he can and still keep his virtual mastery over the course material constant. Put another way, all the material in a PSI course is unitized and presented sequentially. This means the student cannot proceed to Unit 2 of the course work until Unit 1 is completely mastered and evidence of this mastery is shown through test performance.

There are several inherent benefits to self-pacing by the student. First, Carroll (1963) states that in general aptitude is the amount of time usually needed by the student to attain mastery of a learning task. The self-paced course, then, allows the content to be learned at differing rates; this approach is significantly more efficient for the student-learner. Now, for possibly the first time in his college career, he can study for and take examinations on content material when he is most ready and not simply because the date for an examination, determined by the instructor, has arrived. When events occur (as they invariably do in any student's life) which make effective study impossible, the student may choose to wait until mastery of the material has occurred. It is important to point out that both the mastery concept

and the emphasis on student self-pacing are a basic feature of several types of individualized instruction, such as programmed instruction, computer-assisted instruction, and individually prescribed instruction, and not the unique province of a Personalized System of Instruction.

The Use of Lectures and Demonstrations as Vehicles of Motivation rather than Sources of Critical Information

The traditional lecture system in higher education has been used as the vehicle for information dissemination for centuries. The benefits of a lecture system derive largely from the fact that a teacher may assemble many students in one place at one time to present important information in the course. This method of traditional instruction is very efficient for the teacher. He may plan precisely the amount of material he wishes to cover in a class meeting. He may plan precisely the pace at which this crucial information will be presented. The result of this system should, in most cases, be a highly polished series of lectures in which the student serves as the passive receptor of the information being presented to him. This usage of "passive" simply means that the students in most large lecture settings cannot actively or immediately respond to the information that is being presented. Therefore, the student is not able to find out whether he has truly learned or even understood the information until a considerable time period has elapsed, often as long as several weeks.

For effective learning, according to current learning theory, the student needs to be "placed in a position where he must respond, where he receives nearly immediate feedback from his efforts, where he may proceed at his own pace, where punishing contingencies are made minimal, and where his individual work is monitored at every step as he proceeds through a carefully designed sequence of materials requiring an increasingly complex performance" (Sherman 1967).

Lecturing, in the traditional sense, fails on all counts. The student is passive in most classroom lectures because the situation is so structured that he has no opportunity to respond to the material being presented. The chance for immediate feedback in the lecture system is also impossible without active responding. The lecturer controls the pace of information presentation, allowing little opportunity for self-pacing by the learner.

It should be clear that, while lecturing does have advantages that make it important in the overall teacher-student educational experience, it is not the most efficient technique to insure efficient and effective learning.

Yet, there are real advantages to utilizing lectures in a total educational system such as PSI. If the teacher lectures well, then the lecture itself should be an important and highly reinforcing event to the students taking the course. The PSI instructor may now use study materials, self-paced testing, and mastery to present essential information to his students. Being removed from the usual burden of presenting essential but often routine or somewhat boring course content to the students, the instructor may now institute a series of lectures that can touch on topics not essential to the actual course content but interesting and informative in their own right. This should make the lecture a pleasurable experience for both student and instructor, and something that could easily serve as a motivation to students who know in advance that to be allowed to attend they must have reached a certain level in the course. The lecture in a personalized course is not eliminated, as in many other forms of individualized instruction, but serves a different, highly useful function.

The Use of Proctors

The fifth and possibly most important feature in the Personalized System of Instruction is the reliance on undergraduate students to serve as peer-tutors. Student proctors may be advanced students who have previously evidenced superior performance in the course during an earlier semester or they may be students actually taking the course but more advanced than their peers. (More will be said in the "logistics" section on the actual selection procedures of the various types of proctors.) At this point, it is important to emphasize the peer-proctor effect in a personalized learning process. Keller (1968, p. 21) describes a proctor as "an undergraduate who has been chosen for his mastery of the course content and orientation, for his maturity of judgment, for his understanding of the special problems that confront the student as a beginner and for his willingness to assist."

A peer-proctor system works effectively because the proctors, being undergraduates who have only recently mastered the material, can communicate subtleties of the course content to other students in a way that is readily understandable. This communication is not always in evidence when a highly educated professor tries to discuss course content with an undergraduate.

Another important advantage of the peer-proctor system is that of freeing the instructor from the "highly predictable, redundant, repetitive errors and questions, that preclude his dealing with the complex, personal and unique questions that only he is equipped to handle"

(Sherman 1971b). Thus, the instructor can be free to handle the many crucial course functions, such as study material preparation, multiple test preparation, course management problems, and serving as the final arbiter in any questions arising from test grading or content explanation.

The proctors also gain from their interactions with fellow students. As Sherman puts it, the proctors "come early, work late, learn even more than other students, and go on to take the top grades in the advanced courses (as yet traditionally taught)" (Sherman 1971b).

Proctors are, some feel, the single most important feature of the Personalized System of Instruction, for it is through their unique contribution to the instructional process that PSI gains its truly "personalized" aspect. The student can gain, even in a large class, a highly personalized, one-to-one contact with a fellow student. The advantages of this individual contact are obvious—not only is each student given immediate feedback on his level of test performance, but also an "enhancement of the social-personal aspect of the educational process occurs as well" (Keller 1968, P. 23).

Summary

The five basic features of the Personalized System of Instruction have an overriding and consistent purpose: to increase the effectiveness of instruction. The self-pacing, mastery, and emphasis on written material features are proven techniques for increasing learning efficiency. When coupled with the additional features of using students as peer-proctors in the instructional process and using lectures as motivational devices, one sees an instructional system emerging that uses existing knowledge of current learning-reinforcement theory and effectively incorporates it into the existing classroom-lecture framework of most institutions of higher education with a minimum of disruption.

No examination of the basic features of a Personalized System of Instruction would be complete without a discussion of the distribution of final grades found in a PSI course. The grade distributions are inverted from the normal curve found in most of the more traditional course settings. Keller (1968) found that the highest proportion of students in a PSI course receive A's by the semester's end, with the proportion of the total dropping rapidly through the B, C and D category, and gradually rising again through the F's, incompletes, and withdrawals.

The reason for this inverted function is not hard to find. Students are told specifically what is expected of them in each unit through the behavioral objectives presented. The student is then given complete study guides to meet these objectives, immediate feedback on all test performances, and a testing procedure that eliminates any "failure" in the usual sense. Therefore, in a well designed PSI course, the percentage of A's is high because an A represents mastery of all the important content of the course that should be learned by everyone. The ideally successful Personalized course would have all students earning and receiving A's simply because they have learned all the course material expected of them and have proven their learning by their test performance.

The relatively high proportion of incompletes and withdrawals in a Personalized course can be largely attributed to the same general list of variables mentioned above as responsible for the high number of A's. At first, this may seem contradictory, but if one puts oneself in the student's place, being made aware of specific learning objectives and being constantly tested and receiving continual feedback on rate of progress, then the possibility of an unsatisfactory course grade is determined far in advance of the semester's end. This advanced knowledge allows many students the opportunity to withdraw early, in contrast to most traditional courses where students may continue through an entire course with no real understanding of what determines their final grade.

The Management of a Personalized Course

This section will deal primarily with logistical problems and methods necessary to successfully manage a personalized course. At this point it should be beneficial to show how easily a PSI format will fit into the traditional organization of our educational system.

1. The PSI format utilizes conventional classroom facilities and does not require a special learning center or elaborate physical plants.

2. The PSI course easily adapts to the traditional course time limit, which is usually three or four hourly class meetings per week. Although the PSI format can adapt to this schedule, longer class meetings do seem to be more efficiently utilized by students. The longer sessions allow for increased testing time, thus permitting students who need to be retested on a unit exam to do so on the same day.

3. In addition to the use of regular classrooms and course scheduling, the personalized course also relies heavily on traditional texts and materials.

As outlined above, it is apparent that PSI is amenable to the traditional college or university structure. However, the characteristics and differences found in the Personalized System of Instruction become more pronounced when one enters the classroom.

General Classroom Structure

The following discussion centers around the characteristics of an "average" PSI classroom. It should be recognized that although the PSI format allows many variations in classroom management, the slight differences among PSI classes are not as important as their similarities.

When entering a personalized classroom, the visitor's first impression is that of continual physical movement. In the front of the room a student positioned behind a table is signing out test materials to a constant flow of students entering the classroom. Once receiving test materials, students move to a section reserved for test taking. As soon as a student feels his test is ready to be graded he moves to another area where a student-proctor obtains the appropriate answer key and scores the test. If the tested student has answered incorrectly on any question or indicates confusion, the student-proctor will privately tutor the student on the test materials. The proctor then marks the exam and the student goes back to the front table to turn in his com-

pleted test. The student has three options at this point. (1) If he has failed to master the previous test, he may retake another form of the unit exam. (2) If he has mastered the completed test he may move on to the next unit exam. (3) He may decide to wait until later to undertake another unit exam. If he decides to wait, the student may elect to take advantage of a study section in the back of the class or he may leave the class to study elsewhere.

The instructor is always present and in constant motion—first to the front of the room to insure that all test materials are properly signed out and that proctors are thoroughly discussing test materials with students—then to the back of the room, where he answers student questions arising from the study of course materials.

Thus, the first impression may well be that the Personalized System of Instruction is a very disorganized process. On the contrary, efficiency is the cornerstone of the system. Students do not come to the classroom until they are ready to show their mastery of course content, and are free to leave when they have accomplished their own goals. Obviously, then, the effectiveness of any PSI format depends heavily on the smooth operation of all the major elements of classroom testing procedures.

The above discussion leads to consideration of the logistical components necessary to the successful management of a PSI course.

Preparation of Materials

The personalized course places great emphasis on the written word. The written word comes to the student by way of a traditional text and the use of a supplementary study guide keyed to the text material. A personalized course, as with more traditional course structures, is enhanced by a text that presents material in a well organized and compelling manner. Unfortunately, text materials are occasionally incomplete, overly complex, disorganized, or written in a way to lose the reader's interest.

Widely varying quality in course texts can be compensated for by utilizing properly developed course materials such as study guides. A study guide should ask questions on important text materials, state learning objectives for each unit, and help guide the student through mastery of complex course content. However, study guides, like the texts to which they are keyed, vary widely in style. These variations are acceptable as long as the basic features of good study materials are present. Specifically, a good study guide should present content in small, logically sequential units that require students to actively re-

respond to the material. This active responding usually takes the form of answering questions also found in the study guide.

As any instructor can testify, competent and thorough study materials are essential components of a successful course. The text and study guide should not only present the course content in a complete manner, but must also capture and hold student interest. Without such student involvement, a personalized course will probably suffer major problems in student procrastination. No amount of high quality course management can overcome the effects of poor or uninteresting course materials.

While each study guide differs as a function of both the author and the type of content being covered, there are some rules-of-thumb on unit size that should be noted. The standard number of units in any course study guide should be roughly equal to the number of weeks that the course is in operation. This allows the students to have at least two or three test sessions for each unit (depending upon how many class meeting periods are scheduled in a week). This permits the student flexibility in self-pacing, in that he is not "forced" to maintain as rapid a pace as he would if there were too many units in the course package. A higher number of units can cause serious problems for students who fail a unit exam one test day and almost immediately fall behind in their progression through the course. Too many units tend to "pace" a course, perhaps unintentionally, and reintroduce the adversive "do or die" testing element found in many traditional lecture courses.

Too few units are viewed as adversive to the student simply because the amount of material to be mastered for any one test is so great. The overly large unit often instigates higher rates of procrastination in student self-pacing. Therefore, unit size and length is of great importance for a successful, personalized course. The final decision on how many units to use in a given course, as well as the content to be included in each unit, rests with the instructor and should be subject to flexible revision after each course offering.

Other course materials of crucial importance in determining the success or failure of any PSI course are the unit quizzes or test forms. Since students are required to master each unit, they should be given the opportunity to take several equivalent test forms until they reach the mastery level of performance. A student who performs at a mastery criterion on the first test form may then continue to the next unit. A student who does not perform at a mastery level will need to receive a second, third, or fourth quiz on the unit. Multiple

test forms on any unit must be as similar as possible in terms of the general categories of test items presented. Test forms that are not equivalent would be unfair to the students. For just this reason, it is important to draw questions from clearly delineated content areas in the study materials. It is also important that this content be sampled on each individual unit test form. There exists an informal method for developing unit test exams that should not be overlooked. If possible, tests should be 10 or 15 minutes in length and should consist of items such as true and false, multiple choice, and short answer essays—forms that are answered and scored quickly. The shorter tests allow students the opportunity to take more than one unit exam in a given test day should they not achieve mastery on their first attempt. There is nothing more frustrating for the capable and highly motivated student than to come to testing and leave after not passing several unit test forms.

The value of thoughtfully conceived study and test materials should not be underestimated. Good materials that successfully guide the student to the importance of the content he is to learn and carefully prepared testing procedures are the cornerstones of PSI and must not be short-changed.

Course Personnel

Another vital element in successful PSI course management is the individuals whose duties make possible the "personalized" aspects of the system. They can be divided into three major categories: the instructor, the proctor, and the class assistants.

The instructor's role in a well-run PSI course is basically that of a course manager. This means that all the elements of course design are the exclusive responsibility of the instructor. The PSI instructor is responsible for the proper development and distribution of *good* written materials, which includes both study guides and test forms. This task alone may take months of preparation. Once the materials are developed and the class finally begins, the instructor is responsible for decisions on all aspects of course policy and personnel. Decisions must be made, such as how many students should be allowed in the course, how many proctors should be used and how they should be selected, how many assistants should be used and what duties should be assigned, and how the massive bookkeeping involved in such a course should be designed and handled. There are perhaps hundreds of smaller, day-to-day, crisis decisions regarding all phases of classroom policy that rest solely with the instructor.

Beyond these responsibilities, the instructor must be present during testing sessions to answer any and all questions that students may have on course content. Obviously, the final arbitration of disputes between a student and proctor arising from testing is also the responsibility of the PSI instructor. It is certain that anyone thinking of undertaking a PSI format to save work or to escape lectures will be sadly disappointed. The amount of time necessary to undertake a PSI course is significantly higher than that needed to teach a traditional course.

Proctors are another essential component of the PSI course personnel. Proctors or "tutors" are those students who have successfully mastered previous course material and are capable of grading and assisting students less advanced in the course. They are selected by the instructor on the basis of their demonstrated knowledge of course content and their willingness to help other students. The usual proctor-to-student ratio is roughly one-to ten in most PSI courses.

Proctors may be chosen in several ways, but the most prevalent method is to select a fixed number of proctors who will serve the entire course. These "external" proctors are often graduate students or advanced undergraduates majoring in the discipline who have demonstrated mastery over the material.

The other major procedure used in proctor selection involves the use of students enrolled in the course. These "internal" proctors are students who have proven their mastery of the greatest number of course units by any given test day. This means that only those students who are most advanced in the course will be eligible to proctor. This added eligibility requirement introduces a slight competitive element into the classroom. Highly motivated students have an added goal of maintaining a sufficiently swift pace to merit the position of proctor.

Proctoring, whether by external or internal procedures, pays real dividends to all involved. Often, for the first time in their educational career, students are able to discuss critical course material on a one-to-one basis with their peers. This also occurs with the professor, who is available to answer any question in an environment which is non-threatening for the student. For the first time students are not being lectured from the podium but are encouraged to actively participate in the learning process. For the students taking the course, it is largely the proctor who provides the face-to-face "personalization" factor. In other words, the selection and utilization of proctors is a most crucial factor in any personalized course.

The proper use of class assistants is also important for successful PSI class management. Class assistants may be graduate or undergraduate students who are paid a salary or given independent study credit. Assistants usually number only one or two for an average PSI course of less than 100 students. These assistants are responsible for the test-checkout procedures and for the vast bookkeeping necessary for a PSI format. Assistants must be chosen with utmost care since test security and proper recordkeeping are absolutely essential.

Additional Course Management Considerations

There are several other management decisions that should be made when undertaking a PSI course. PSI allows a variety of additional activities to be carried out in conjunction with the basic course procedures. Activities such as the use of supplementary lectures or the use of audio-visual materials are common. Each added activity produces unique management problems and should be examined carefully before being undertaken. It is important to remember that any supplementary course activity should be scheduled at time periods other than during scheduled testing hours. When a competing activity is scheduled during testing, the student must choose between slowing his pace, something not recommended by the instructor, or not attending the extra activity. Students often choose to continue with testing unless the supplementary activity is an integral part of the final course grade. It is a good idea to keep supplementary activities to a minimum the first time through any PSI course.

The Final Examination

The final examination is a usual feature in most PSI courses. With proper use, the final examination serves the major function of allowing the student to tie together all content learned throughout the course. It also serves as a useful check on those students who may have used less than laudatory methods for getting through the course.

Finals should be of the same type as the earlier unit tests. In other words, if multiple choice tests are given during the unit quizzes, the final examination should also contain multiple choice items.

Most PSI instructors who decide to give finals in their courses administer only *one* final to each student. This means the final may not be taken several times until mastery is attained. There is no reason, other than one of logistics, why multiple finals should not be given. Certainly, in self-paced PSI courses it is highly advisable to give the final several different times during the semester. This allows

the early finisher to reap the full benefits of his rapid pace and complete the PSI course weeks before the conventional end of the semester or quarter.

The use of the final examination is not essential in some PSI courses where several review units are included in the course structure. Well written review units may accomplish the same function as the final examination without producing the anxiety that often accompanies a "one-shot" examination.

Summary

Good course management is essential if any PSI course is to succeed. One cannot overemphasize the value of selecting quality proctors and course assistants, writing high quality study and test materials, and selecting appropriate supplementary course activities. In addition, one must never overlook the necessity of providing the students with a complete course syllabus outlining in detail every aspect of course policy, no matter how minute.

Any miscalculation by the PSI instructor such as underestimation of the number of proctors needed or poor bookkeeping procedures will almost inevitably show up in the form of lines in the classroom. If you have poor bookkeeping, lines of students will form at the front desk waiting for tests. If you have too few or poor proctors, lines of students will form waiting to have their tests graded and discussed. If you have too many units or too much overall content programmed into your course, the result will be a terrible crush of students trying to finish everything late in the semester. There is nothing more demoralizing to the students and instructor than this type of chaotic situation. Only months of thoughtful planning and preparation well before the first student enters the classroom will keep a course running smoothly and efficiently.

Current Research Findings

As the number of successful applications of the Personalized System of Instruction increases, so do the amount and variety of research attempts to judge its effectiveness. The great bulk of research dealing with PSI has originated within the last 5 years and the wide variety of this research presents great problems to anyone trying to gain a clear picture of the effects of either PSI in general or specific components of the system.

However, there are serious problems inherent in the measurement of any new educational technique. A great many studies have attempted to compare PSI with another more traditional educational technique, with the second technique serving as a control condition. This control condition is often a post-hoc selection of a new PSI user's lecture course from the previous semester. The obvious changes that occur from one semester to the next in terms of the types of students enrolled in the course as well as the new educational perspectives of the instructor render scientific analysis of PSI difficult at best. A major problem inherent in most between-subject experimental designs in classroom settings stems from the lack of adequate random selection or matching of students to serve in each condition. Problems of this kind allow little generalization to be made about the experimental results.

"Within-subject" experimental designs have been attempted by a number of investigators, particularly behavioral psychologists, to assess the effects of varying teaching methods within an on-going course. The problems with these methods arise largely from the fact that any sequential presentation of varying teaching methods, whether of a standard ABA design or a more complex multiple type, will have substantial residual effects from the previous teaching methods employed.

It is important to point out these weaknesses in experimental design if for no other reason than to warn the reader that no study is beyond criticism or without methodological flaws. There is, however, a strong trend emerging from data collected in a number of studies that should provide a clearer picture of the effects of introducing a PSI instructional format.

When one reads the literature pertaining to PSI, two types of studies emerge. The first type centers around the general question of

whether PSI produces substantially diffierent outcomes in student performance as compared to traditional educational approaches. Within this general framework many important questions arise, including: (1) Does PSI increase test performance? (2) Do student withdrawal rates affect performance in a PSI course format? (3) How do students evaluate the PSI course? (4) Does PSI affect student retention rates?

A second type of study that appears in the literature assesses the effects of various "components" of Personalized Instructional techniques. Aspects of the system most often studied are: the effects of self-pacing on student performance; the effects of proctor usage in the PSI format; the effects of proper material usage (such as appropriate unit size and question type) on later performance; the effects of various levels of mastery on performance; and the effects of lectures as a motivational or incentive device.

Outcome Studies

Many descriptive reports have pointed to the large number of high grades (A's and B's) in a PSI course as evidence that the personalized method is more effective than a more traditional lecture format. Many report that the same instructor will assign more A or B grades when he teaches a course using PSI than he did in an earlier semester when teaching in a more conventional manner (Keller 1967, 1968, 1970; Moore, Mahan and Ritts 1969; Hoberock 1972). While the grade distribution does radically change in most PSI courses, the simple presentation of grade distributions or of verbal reports by the students earning the higher grades is no substitute for observing what the subject does with the material.

Several experimenters have compared students in traditional lecture and in PSI courses based on examination performance (McMichael and Corey 1969; Corey and McMichael 1970; Moore, Mahan and Ritts 1969; Gallup 1974; Sheppard and MacDermot 1970; Morris and Kimbrell 1972; Witters and Kent 1972; Alba and Pennypacker 1972; and Born, Gledhill and Davis 1972). There are similarities in the results to be found in the research literature. The first and most important is that all studies report that PSI is at least as good as, if not better than, more conventional techniques. An approximate calculation on the previous studies mentioned shows that the increase in PSI performance ranges between 10 and 15 percent above traditional lecture approaches.

In a representative study, McMichael and Corey (1969) found that PSI psychology students performed significantly better on multiple

choice exams than did three control sections using the same text and covering the same material ($p<.0001$). In a replication of this study, Corey and McMichael (1970) found even greater differences in final examination performance, with the PSI students again performing significantly higher.

When the Personalized System of Instruction was first utilized, many educators and researchers had serious reservations about the effectiveness and limitations of the system. There was much speculation that PSI was probably useful in teaching simple academic skills that were bound by strictly defined and limited subject areas. Many felt that Personalized Instruction could not be utilized in conceptual or creative learning. Now there are experiments that demonstrate increased student performance on tests requiring both recall and application when a personalized format is used rather than a more conventional presentation of content material (Morris and Kimbrell 1972). Sheppard and MacDermot (1970) also found superior results in the Personalized Instruction group when essay answers were required as performance measures. However, in their study the unit quizzes were in the form of oral interviews (Ferster 1968) requiring some practice of verbal fluency which may influence essay answering behaviors.

Born, Gledhill and Davis (1972) found that students were not handicapped in performance on a complex final examination by prior exposure to the shorter questions and answers required for unit quizzes. Other experimental data confirm these general findings (Hursh *et al.*, 1973). Thus, a considerable amount of research seems to verify that PSI is effective in courses stressing the acquisition of complex academic repertoires. It is clear, however, that numerous and more controlled experiments need to be conducted in areas other than basic psychology before this controversy can be conclusively settled.

Another basic criticism is that within a personalized instructional format, students have more exposure to test questions than do control groups. Many feel that this "practice effect" could be the significant contributor to better performance scores. However, in a well designed experiment the final exam should not contain items which the PSI students alone have seen. Although many studies are unclear about prior exposure to test items, the McMichael and Corey (1969) and Corey and McMichael (1970) studies do not contain such a bias.

Another study by Alba and Pennypacker (1972) managed to control for this particular bias by administering fill-in items to the experimental group and multiple-choice items to the control group. Since the final exam for both groups consisted of both types of questions,

students in both groups had been exposed to final examination test items on a random basis. This procedure seems justified, in that test validity may be different for the two groups if an "independent final evaluation" is administered. Pretest to posttest change scores also were computed as an evaluation procedure necessitating the use of identical items. It is interesting to note that the experimental group performed significantly better on both types of questions. However, if memory processes involved in recall are considered to be of a higher-order nature than those involved in recognition, then the control group would seem to have an advantage in pre-final testing. On the other hand, the control group would be at a disadvantage on the final in that they had no prior exposure to the more difficult fill-in item construction. Thus, these results should be reviewed with caution.

There is a concern that greater exposure to test items of the same form (fill-in, multiple-choice, etc.) might be the crucial variable in superior final examination performance by Personalized Instruction groups. Born, Gledhill and Davis (1972) report that students in the PSI group had received both essay tests and fill-in quizzes throughout the semester in addition to the same mid-term and final taken by the lecture group. Thus, there were "many opportunities for proctors to 'shape' examination writing skills" (p. 42). Although the proctors had no opportunity to affect appropriate answering of multiple-choice items, the PSI group performed somewhat (but not significantly) better.

Moore, Mahan and Ritts (1969) tried to control for this in their biology and psychology courses by giving the unit quizzes to all experimental and control groups. They found superior final examination performance for both PSI groups. Unfortunately, the weight of the final examination in determining the course grade was unclear. If one assumes that grades are a motivating factor, differential examination performance may be due to the value a final exam has for a given course. This criticism may also apply to the Clark (1973) Introductory Sociology Comparison study. A controlled experiment must indeed hold this factor constant.

It is interesting to note that several studies have introduced biases favoring the control group. For example, the final examination on Sheppard and MacDermot's (1970) programmed course did not affect the final grade while the exam accounted for 50 percent of the control group's final grade. They still found that final exam performance was significantly better for the programmed group. In the McMichael and Corey study (1969), only the control group had been previously

exposed to some of the items on the final exam; however, the Personalized Instruction group still performed significantly better.

Withdrawals

Course withdrawal rates have been considered by some to be a variable that influences the performance data. The higher withdrawal rate which often characterizes Personalized Instruction (Keller 1968; Glick 1973a; Born 1971; Born, Gledhill and Davis 1972; Born and Whelan 1973; Phillipas and Sommerfeldt 1972) may influence the overall superior performance of students simply by elimination of potentially poorer students from the performance data. Many studies fail even to mention the withdrawal data. Of those studies that do (Gallup 1974; Sheppard and MacDermot 1970; Phillipas and Sommerfeldt 1972; and Born, Gledhill and Davis 1972), several show a higher withdrawal rate than found for conventional courses, coupled with equal or superior performance for the PSI group, leaving the results open to interpretation. However, many studies have used course procedures that allow noncompletion of course material and include those who elect this option in the comprehensive analysis of final examination data. Austin and Gilbert (1973) found significantly superior performance on a final examination that included five (of a total of twenty-five) students who had not completed all units of the course. Of fourteen unit quizzes, these five students had individually completed thirteen, twelve, eight and six units. Morris and Kimbrell (1972) also noted superior performance by PSI students even when the scores of several students who had not finished the units and two who had not taken the final were included in the performance data. Also striking were the findings reported by Sheppard and MacDermot (1970), which included analysis of scores from students in the programmed section who had not completed the text materials. (Approximately two thirds of the experimental group had completed three-fourths or one-half of the course material for a grade of B or C, respectively.) Upon administration of the final exam, which did not figure into their final grade, the programmed section scored significantly better than the conventional lecture section. Such data suggest that PSI may be able to nullify the effects of withdrawal. Finally, several studies have an approximately equal (McMichael and Corey 1969) or smaller (Malott and Svinicki 1969; Malott and Palm 1971; Myers 1970) withdrawal rate for students in PSI groups as compared to conventional courses, again with test performance favoring the PSI group in most of these studies.

The control group represents another interesting variable (Kulik 1972). The procedures used in "conventional" sections seem to vary widely, so interpretation of the results must take this into account. A question arises whether or not the same professor should teach both sections, personalized and conventional (McMichael and Corey 1969). Moore, Mahan and Ritts (1969) used the same professors in both groups for three disciplines (psychology, biology, and philosophy); Phillipas and Sommerfeldt (1972) both taught each section of their physics course; and Sheppard and MacDermot (1970) had the same professors and teaching assistants in both of their groups (also see Witters and Kent 1972; Born, Gledhill and Davis 1972).

When using different instructors for the control and experimental groups, it is possible and fruitful to control for technique and instructor differences. Indeed, this is another factor to be assessed for its influence.

Phillipas and Sommerfeldt (1972) reveal that they felt "uncomfortable writing objectives and quizzes" and felt that their lecture course control group was the best they had ever presented. Thus, more experience with the lecture system may have contributed to the "no significant differences" that they report. They conclude by stating:

> If, by chance, the reader should interpret the results reported in this work as evidence against the effectiveness of the Keller Plan in Physics teaching, he should consider the following hypothetical situation. Suppose we had all been educated under the system of instruction called the Keller Plan and subsequently, upon entering the teaching profession, continued to use it in our courses. Imagine that the present experiment was done to evaluate a new system of instruction called the "lecture." Our findings would indicate that however hard we worked in the lecture system, it was no more effective than the old and tried Keller system (p. 1305).

Another procedural problem that has not received attention until recently is the presentation of study questions and objectives to control and/or experimental groups. Many studies do not report whether or not both sections received study questions, but most that do refer to the use of study questions point out that both groups received them (Moore, Mahan, and Ritts 1969).

Retention

Three studies have attempted to measure long-term retention differences between PSI and control groups. Corey and McMichael (1970) report that after a lapse of one semester (19 weeks), the same final exam administered in the first half of a two semester course was given without notice to students in the second half of the introductory

psychology course (lecture method). Of the students who were included in the original experiment (30 percent of the PSI group and 24 percent of the three control groups), it was found that the PSI students scored 9.7 percent higher than the control group. The authors concluded that the effects of the method are quite durable. Austin and Gilbert (1973) found similar results in a test for retention after a lapse of 2 months, finding that the PSI students scored 15 to 20 percent higher than the lecture-recitation students. This differential retention rate was greater than the 10 to 15 percent difference found in the original final exam. Cooper and Greiner (1971) found that when 60 percent of both the PSI and control students were given an unexpected long-term retention test (not a retest) on the material covered 5 months earlier, the PSI group performed significantly better ($p < .01$).

It is interesting to note the differential amounts of "forgetting" that occurred in the above three studies. Although there was a linear relationship between amount forgotten in the experimental as compared to control group in a given study, the decreases in performance found in the three studies vary widely. On identical retests, Corey and McMichael (1970) report an approximately 6 percent decrease in scores for both groups. Austin and Gilbert (1973) report an approximate 20 percent decrease in both experimental and control groups. Cooper and Greiner (1971) randomly selected questions from a test item file (students from both groups therefore may have seen some of the questions previously) and found a decrease of 65 percent in performance when compared to the original scores for both groups. Clearly, retention comparisons should be more thoroughly investigated, although there are methodological problems associated with such measures.

Controlled studies comparing PSI with conventional lecture sections have been reported in a number of disciplines other than psychology. Areas of such comparison include physics (Austin and Gilbert 1973; Phillipas and Sommerfeidt 1972); biology (Moore, Mahan and Ritts 1969); economics (Tietenberg 1973); and anthropology (Witters and Kent 1972). Unfortunately, many comparison reports have unavoidably utilized different materials for experimental and control groups (Clark 1973) or materials differing from previous semesters (Hoberock *et al.*, 1972), leaving their results open to question. However, all reports have shown significantly superior performance by the PSI students.

It is interesting that most reports show that (in comparison to psy-

chology) in other disciplines procedures are implemented that more closely follow the original outlines of the method (Keller 1966, 1968, 1970). This is to be expected, especially when one considers that many of the psychology studies have been undertaken by professionals in reinforcement theory and contingency management techniques, and the researchers would thus be more likely to feel confident in experimenting with variations in procedures. The reported success in other areas suggests that the method has wide applicability to other content and can be undertaken by professionals in disciplines other than psychology. These findings contribute to the confirmation of the wide application and generalizability of the method as originally indicated in McMichael and Corey (1969).

One final point must be made in evaluating the results reported here. There is a tendency among researchers (especially behavioral psychologists) to develop their own version of the basic Keller/Sherman plan. Many of these versions are quite complex; therefore, the superior results reported for their "personalized instruction" course are difficult to apply in the general classroom setting. More importantly, if we consider present comparisons of conventional and personalized instruction procedures to be at a gross evaluative level, and if we begin to ask questions concerning the effects of various components in the system, then further research must utilize procedures that are clearly reported and of general significance to the user of personalized instruction. We must treat each component or aspect of the system as a variable and manipulate it in a systematic fashion, implementing a procedure system that generates generalizable data of significance to the majority of educational programs.

The great majority of the studies summarized above conclude significantly that personalized instruction is more effective in a wide variety of disciplines than more conventional approaches. However, we have seen that the need exists for additional methodologically and procedurally sound studies both within and outside psychology. Behavioral psychologists should also instigate research with single-subject designs dealing with the effects of contingency management procedures in college instruction. Miller (1973), in the reviewer's comments, points out that virtually all past research has relied on between-group designs and expresses consternation over the fact that "our knowledge of the effects of such procedures is based on such weak design" (see also Semb 1973b; Miller and Weaver 1972; and Born, Gledhill and Davis 1972). With respect to this last comment, as well as to the need for more and better comparison studies, Miller and

Weaver (1972) perhaps summed it up best: "Let us remember what happened to the programmed instruction movement as it floundered on the shoals of faith unaccompanied by hard-nosed experimental evaluation" (p. 398).

Component Analyses

The initial cautions that were mentioned with regard to all outcome studies found in the current research literature hold true for any studies utilizing a component analysis of the major features in PSI as well.

Studies that have utilized a component analysis of one or more of the five basic features of the PSI system must be especially careful not to confound the data obtained by the manipulation of more than one component at a time. It is extremely difficult to separate clearly the effects of individual components of any instructional technique. A host of studies have looked at various features of the PSI system, particularly self-pacing (Green 1971b; Lloyd and Knutzen 1969; Hess 1974) and the effect of the level of mastery employed (Miller and Weaver 1972; Johnston and O'Neill 1973; Semb, Hopkins and Hursh *et al.*, 1973). Data derived from both the preceding component analyses are far from conclusive.

Only one study currently found in the literature makes an attempt to study the effects of several components found in a PSI course. This study by Calhoun (1973) administered to a large (N=282) sample of students a pretest and posttest multiple choice examination followed by an examination 3 months later. All students were randomly divided into one of six experimental conditions: (1) a basic PSI package; (2) a basic PSI package plus lectures and oral unit quizzes; (3) lectures with proctoring on examination following a 1-week interval; (4) lectures without proctoring; (5) a basic PSI package without self-pacing; and (6) non-self-paced progression through the course with five paced exams.

Through the use of an elaborate statistical design, Calhoun was able to study the effects of pacing, lectures, unit mastery, and proctoring. His results showed that (1) there were no significant differences between a basic PSI package and a combined PSI and lecture course in terms of pretest to posttest change scores; (2) the non-self-paced course, which utilized a unit mastery criterion, performed significantly higher than the non-self-paced course with only paced testing and no unit mastery; (3) both standard PSI and PSI with lecture conditions performed significantly higher than did either of the non-self-paced con-

ditions; (4) there was no significant difference between either of the lecture conditions, whether or not proctoring occurred; and (5) all unitized conditions, whether paced or self-paced, performed significantly higher than did the lecture conditions.

Calhoun's data show that the effects of pacing, unit mastery, and proctoring are important components in the general overall higher performance of PSI courses, while the effect of lectures, at least when coupled with a standard PSI format, has little effect on performance.

This study is mentioned merely as an example of the type of research that must come in the future if educators are to separate the effects of various elements in the instructional process on student performance.

For additional information on the recent research literature on PSI, the reader is referred to a recent *Science* article by Kulik, Kulik, and Carmichael (1974).

Summary

In many instances the research that has accumulated over the past half decade suffers from serious methodological flaws. For this reason one must be cautious in assessing the results of such research. The bulk of outcome research seems to indicate that PSI performance is equal to or surpasses most traditional lecture approaches. Retention of information for PSI users also seems to surpass most other instructional systems.

Proctoring, unit mastery, and self-pacing seem to be important in the enhancement of the learning process in classroom settings, although more well designed and controlled research needs to be carried out in all areas to create a more complete and generalizable picture. The years to come should create a clearer understanding of the effects of these and other less obvious variables in the educational process.

The Personalized System of Instruction: Today and Tomorrow

The extensive growth of the Personalized System over the past decade has been emphasized. But what about today? What on-going efforts remain to test the efficiency of this instructional system? For any instructional innovation to endure it must be continually examined by those who use it, modified where hard research data shows a change is necessary, and then disseminated to educators in higher education nationally. It is the acceptance by the great majority of skilled educators that often determines whether an innovation effects real educational changes or merely joins the ever growing list of instructional fads or gimmicks that have plagued higher education for the last quarter century.

The research data, even with the many methodological flaws previously mentioned, seem to show that PSI is an instructional system that is capable, when applied thoughtfully and correctly, of producing increased performance by students over more traditional modes of classroom instruction, producing positive student response, as shown by later evaluations, and producing a new spirit in the classroom in terms of changed student-teacher roles.

The research findings presented earlier have a weakness inherent in any undertaking of small size—that of generality of the findings as applied to other, larger, slightly different educational modes. A group of educators at the University of Texas at Austin has embarked on an ambitious 2-year research project, funded by the Alfred P. Sloan Foundation, to look at a number of research questions posed by PSI. The project itself is a massive one, involving numerous professional staff and the development of many PSI courses. The project is to acquire data on some very important and largely unstudied aspects of the Personalized System, such as the relative costs of personalized courses as compared to lecture courses, the question of whether PSI course materials developed by other individuals teaching the same course in another university can be used by a given instructor without a decrease in student performance, and the effect of learned study habits in PSI courses being transferred to other, more traditional classroom settings. Other problems being studied by the Texas group have a small research literature already developed, such as the question of whether students learn more effectively under PSI

or a traditional instructional framework, the procrastination and dropout problems found in some PSI courses, the worth or justification of the inverted grade distributions found in most PSI courses, and, finally, the effect of a PSI format on subsequent long-term retention rates. Some of these research questions have been studied on a restricted scale before, but the Texas effort, under the leadership of James Stice and Billy V. Koen, is the first time so many of these questions have been examined in such a large and systematic way. (More information on this project may be obtained by writing either Stice or Koen through the Department of Engineering, The University of Texas at Austin, Austin, Texas.)

Two other large projects that do not fall entirely in the research domain but are "experimental" in nature are on the campuses at College IV, the Grand Valley State College, Allendale, Michigan, and at the Permian Basin campus at the University of Texas, Odessa, Texas. Both institutions are fashioning their curriculum into a unitized, modularized, and highly personalized mode. Their experiences will help answer questions concerning the effects of adoption of innovative instructional techniques at the institutional level.

The final major undertaking in today's national PSI picture is the establishment of the Center for Personalized Instruction at Georgetown University in Washington, D.C. The Center has a permanent professional staff (J. G. Sherman, Fred S. Keller, Ben A. Green, Jr., and R. S. Ruskin) whose primary function is to exert a leadership role in the dissemination of information relating to PSI. The Center was established with support from the Fund for the Improvement of Post-Secondary Education of the Department of Health, Education and Welfare and the Carnegie Corporation of New York.

The dissemination of information by the Center for Personalized Instruction includes publishing the *Personalized System of Instruction Newsletter*, sponsoring a series of national and regional conferences, sponsoring a series of regional workshops, and developing a comprehensive clearinghouse function for PSI users.

The *Personalized System of Instruction Newsletter* has a readership of approximately 3,000 college or university educators and is published quarterly. The newsletter, which was developed by J. G. Sherman and later assisted by R. S. Ruskin through the Department of Psychology at Georgetown University, is now the major dissemination organ for PSI nationally. The newsletter serves as an information source for educators wishing to keep abreast of important de-

velopments nationally and internationally in PSI, as well as to keep abreast of those teaching by the method in various disciplines.

The Center sponsors an annual National Conference on Personalized Instruction in Higher Education. The 1974 Conference was held in Washington, D.C., in April. Also sponsored by the Center is a series of 1-day regional conferences held in various cities across the country, among them San Francisco, Chicago, New Orleans, Boston, and New York. These regional conferences are intended to expose the college or university teacher to the PSI method.

Workshops sponsored by the Center are of two major varieties: (1) there are a series of intensive regional 2-week workshops scheduled across the country; and (2) the Center will sponsor specific 2-week workshops for individual host institutions.

More complete information on Center functions and copies of the PSI *Newsletter* may be obtained by writing the author in care of the Center for Personalized Instruction, Georgetown University, Washington, D.C. 20007.

There are real problems in trying to predict with any degree of accuracy what will happen to PSI, stemming primarily from the fact that, while the basic method is delinated, there are numerous subtle changes made by each PSI user in order to fit his unique educational circumstances. These changes, while not affecting the system immediately, may have long-term effects that will eventually change the system altogether. The most evident example of this is the recent large scale adoption of the use of "internal" classroom proctors. According to Sherman (1971), this slight change in the normal selection and usage of proctors was occasioned primarily by his unique teaching environment at the time. Sherman could not give independent course credit for proctoring and had no funds to pay his proctors; therefore, almost out of necessity, the within-class selection of proctors was tried. Such changes in the basic PSI system are almost a certainty as the number and variety of teachers using the method continues to increase.

Another trend for the PSI of the future seems almost inevitable. This is the extension of the method into other disciplines. Disciplines such as Philosophy, the Fine Arts, and English will use PSI with much more regularity as the method becomes more widely known and the sophistication of its users continues to increase.

As the number of users in higher education increases, it seems probable that PSI will be applied to other populations and areas of education. Undoubtedly, PSI will be utilized in secondary educa-

tion with much more regularity. There are several published reports on the use of PSI in elementary, junior and senior high schools that are just beginning to surface. These and other reports will generate interest in these areas.

Adult continuing education is another area where PSI is likely to have impact within the next few years. PSI should lend itself nicely to a concept of adult education that allows working adults to continue their education at a pace that takes into account the many constraints of their working environment. In fact, adult education may be the major extension of PSI in years to come.

Summary and Conclusions

The preceding sections have taken an in-depth look at the Personalized System of Instruction (PSI). This innovation in education was developed in Brazil a decade ago by Dr. Fred S. Keller and his colleagues Drs. J. G. Sherman, Rudolfo Azzi, and Carolina Montuscelli Bori. Since the initial development, PSI, or the Keller Plan, has undergone substantial growth and now is used as a teaching technique by several thousand teachers in higher education world-wide.

The Personalized System of Instruction emphasizes five basic features in its operation:

1. An emphasis on the written word, i.e., written study guides and materials that are specifically designed to supplement existing traditional texts.

2. An emphasis on a "mastery" philosophy of learning that allows the learner to progress to the next segment (unit) of material only after he has successfully demonstrated complete knowledge of the existing material.

3. Self-pacing—an essential feature in any instructional system, which allows for individual rates of learning.

4. The use of lectures for learner motivation instead of just learner information.

5. The use of students to help tutor other students in a "peer-proctor" relationship.

The PSI system produces a very different classroom environment as the teacher and students interact in much different ways than has been true in the past. The logistics of such a classroom are complex and are reviewed at some length.

In summary, PSI is a method of instruction that combines the strengths of basic learning theory and individualized instruction (i.e., active responding, immediate feedback, small sequential steps, self-pacing, and mastery) with a highly personalized relationship between students as well as between the student and the instructor. It has been noted that this instructional system, while emphasizing five basic features, is by no means inflexible to the needs of different individual users in different disciplines at different institutions. This very flexibility helps insure the system's viability in the face of anticipated changes in higher education during the years to come.

Research sophistication in this area should point to new refinements and thus keep the system in a position to provide an effective instructional alternative in higher education.

It seems clear that the fifth revolution has arrived in education. No longer can innovations in educational technology like PSI be viewed as an interesting "gimmick." Higher education, as a result of soaring costs, leveling enrollments, and decreasing finances, must look to educational technology to provide new types of quality educational systems. The very survival of higher education depends upon its acceptance of this fact.

Readers interested in obtaining more information on PSI should write to:

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